Catalogues of giant radio sources

Agnieszka Kuźmicz[1,2]

[1] Astronomical Observatory, Jagiellonian University, Kraków, Poland
[2] Queen Jadwiga Astronomical Observatory, Rzepiennik Biskupi, Poland

Introduction

Giant radio sources are peculiar class of objects due to the extremely large ($>$ 0.7 Mpc) sizes of their observed radio structures. It is believed that this is relatively rare feature, because only ∼6% of all known radio sources exceed this size (e.g. [1]). The reasons why some radio sources have grown to such large sizes are not fully explained, however detailed multiwavelength studies have progressed significantly our knowledge about the nature of giants (e.g. [2-5]).

It is considered that the large sizes of giants can be due to: advanced age of the radio source, lower density of intergalactic medium in which the radio jets propagate ([6], [7]), more powerful active nuclei located in the centres of the host galaxies ([1], [8]), advanced age of the radio structures ([3], [19]) or multiple episodes of their radio activity ([9], [10]). However, we still don't know which of the above factors are most necessary to create giant radio source. Most likely, several of them have to occur at the same time.

Catalogues of giants

The crucial point in research of giant's origin is studying large and homogenous samples of such objects. Thanks to the work of many scientists, a lot of new giant radio sources where found during last several years.

- Kuźmicz et al. 2018 ([11]) is a complete compendium of giants published and found till 2018 year. In this work we catalogued 349 radio sources with sizes up to 4.7 Mpc. They span a wide range of redshifts ($0.016 < z < 3.22$) and radio powers ($23 < \log P_{tot} < 28.3$ W/Hz). The collected sample significantly increased the number of giants at high redshifts ($z > 1$), as well as those with sizes exceeding 2 Mpc.

- Dabhade et al. 2019 ([12]) completed sample of 239 giants (of which 225 are new discoveries) using low frequency sky survey – LOFAR Two-metre Sky Survey first data release ([17]). It covers only 424 deg^2 region, but the survey is very sensitive on low surface brightness features and it has a high resolution, what makes LOFAR survey a valuable tool in identifying giants.

- The smaller sample of giants was compiled by Kozieł-Wierzbowska et al. 2020 ([13]), as a part of ROGUE project. The authors catalogued all radio galaxies with extended or unresolved radio morphologies associated with optical counterparts. They catalogued 32 616 radio galaxies of which 33 are giants.

All giants collected in above catalogues were found based on semi-automated search techniques, as well as "systematic" visual search and findings of individual radio sources. The largest number of giants is recognised in the sky regions which are covered by the Faint Images of the Radio Sky at Twenty-Centimeters (FIRST, [14]) and NRAO VLA Sky Survey (NVSS, [15]) radio surveys, with availability of optical data from Sloan Digital Sky Survey (SDSS, [16]). As it was pointed out by [11], despite that some regions are covered by both radio and optical surveys the number of giants found in this regions is still very low. For example such regions are placed near the North Galactic Pole ($12^h < \alpha < 14^h.4$, $0^\circ < \delta < 18^\circ$) and in an area bounded by $21^h.8 < \alpha < 3^h.6$, $0^\circ < \delta < 18^\circ$. The deficiency of known GRSs in those particular regions is not because of a lack of radio and optical data but due to lack of conducting any systematic surveys for giants.

Statistical estimates [11] show that the number of giants should be much larger than the number of giants known today. The current number of giants is not only limited by the availability of radio and optical data, but also by the sensitivity of the radio and optical surveys. Assuming homogeneous distribution of giants on the celestial plane and the detection sensitivity of surveys similar to the sensitivity of FIRST/SDSS, the total number of giants should be at least 2000, and for sensitivity of LOFAR this number is six times larger [12]. It shows that we should expect to find a lot of new giants, even based on data available for years.

Searching for a new giants

In our work we would like to find missed giants based on NVSS, FIRST and SDSS surveys. We plan to search them in a systematic way, focusing first on the regions with low number of radio sources identified as giants.

In our preliminary search in a whole FIRST survey coverage we found 75 new giants of which nearly half are quasars and 17 of them are high-redshift ($z > 1$) sources. Most of new giants were selected throughout cross-machng of the FIRST Catalogue of extended radio sources ([18]) with SDSS sky survey. In this automatic search we found more than hundred candidates. In next step we carefully verified the sizes, morphologies, positions of host galaxies and redshifts, what reduced the number of giants to 65. The next 10 giants were found throughout systematic search in a narrow strip of declination $\sim 12^{\circ}$ and rectastension range $0^h - 1^h$. It shows that large number of new giants can be found in such a way, therefore in near future we plan to begin the systematic search of giants. We realise, that this work is very time consuming and require a lot of patience but it will significantly enlarge the number of known giants giving an oportunity to provide an extensive research bringing us closer to understanding the nature of giants. In Figure 1 we plot the distribution of giants known to date – catalogued by [11], [12], [13], as well as our new findings.

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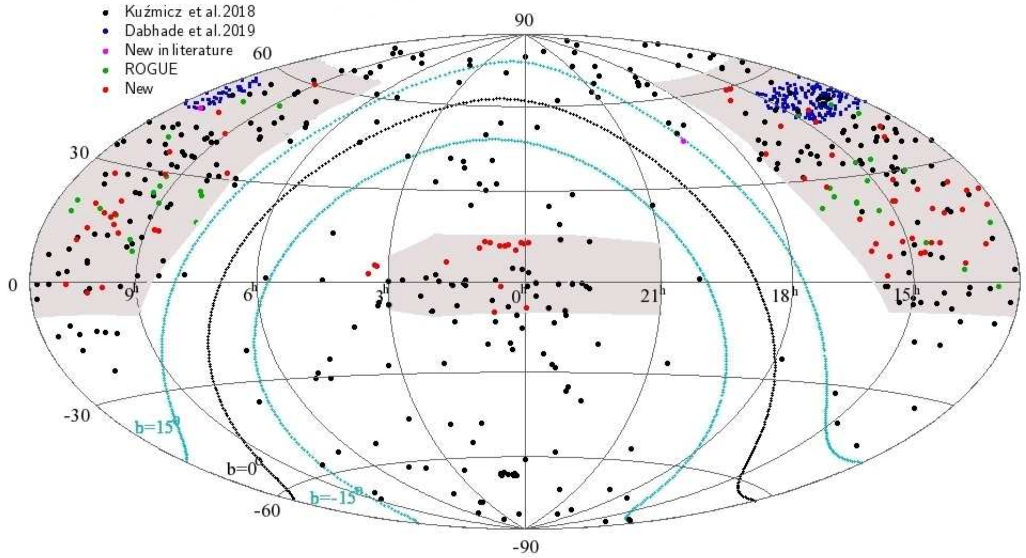

Figure 1. Distribution of GRSs in the plane of the sky in equatorial coordinates. The blue lines are plotted at Galactic latitudes $b = \pm 15°$ denoting the larger Galactic extinction regions. In grey we coloured the sky area that is covered by the FIRST survey.

References

[1] Ishwara-Chandra C. H., Saikia D. J., 1999, MNRAS, 309, 100

[2] Jamrozy M., Konar C., Machalski J., Saikia D. J., 2008, MNRAS, 385, 1286

[3] Machalski J., Jamrozy M., Saikia D. J., 2009, MNRAS, 395, 812

[4] Konar C., Jamrozy M., Saikia D. J., Machalski J., 2008, MNRAS, 383, 525

[5] Kuligowska E., Jamrozy M., Kozieł-Wierzbowska D., Machalski J., 2009, AcA, 59, 431

[6] Machalski J., Jamrozy M., Zoła S., Kozieł D., 2006, A&A, 454, 85

[7] Subrahmanyan R., Saripalli L., Safouris V., Hunstead R. W., 2008, ApJ, 677, 63

[8] Kuźmicz A., Jamrozy M., 2012, MNRAS, 426, 851

[9] Subrahmanyan R., Saripalli L., Hunstead R. W., 1996, MNRAS, 279, 257

[10] Machalski J., Jamrozy M., Stawarz Ł., Kozieł-Wierzbowska D., 2011, ApJ, 740, 58

[11] Kuźmicz A., Jamrozy M., Bronarska K., Janda-Boczar K., Saikia D. J., 2018, ApJS, 238, 9

[12] Dabhade P. et al., 2019, 2019arXiv190400409D, accepted to A&A

[13] Kozieł-Wierzbowska D., Goyal A., Żywucka N., 2020, 2019arXiv1912 09959K, (submited to ApJS)

[14] Becker R. H., White R. L., Helfand D. J., 1995, ApJ, 450, 559

[15] Condon J. J., Cotton W. D., Greisen E. W., Yin Q. F., 1998, AJ, 115, 1693

[16] Albareti F. D., Allende Prieto C., Almeida A. et al., 2017, ApJS, 233, 25

[17] Shimwell T. W., R ottgering H. J. A., Best P. N. et al., 2017, A&A, 598, A104

[18] Amirkhanyan V. R., 2013yCat.8094....0A

[19] Mack K.-H., Klein U., O'Dea C. P., Willis A. G., Saripalli L., 1998, A&A, 329, 431